AICRP-PIGEONPEA

Objectives

- Collection, evaluation, maintenance and characterization of germplasms.
- To create genetic variability for yield and yield related traits.
- To develop high yielding, early maturing, disease resistant and insect resistant/tolerant varieties of pigeonpea suitable for rice-wheat cropping system of North West Plain Zone.
- To develop varieties tolerant to different abiotic stresses like cold and terminal drought etc.
- Genetic investigation on various aspects to generate basic knowledge in the area of genetics and plant breeding.
- To produce nucleus and breeder seed of released and pre-released varieties.
- To develop integrated nutrient management package for pigeonpea based intercropping system of NWPZ.
- To characterize the nature and magnitude of weed competition and to develop suitable weed control strategies.
- To screen out suitable urdbean variety/varieties for intercropping with pigeonpea in NWPZ.
- Intensive field screening in sick nursery of available indigenous and exotic germplasms to find out sources of resistance against Phytophthora Stem Blight (PSB).
- To develop and recommend suitable management strategies including integrated disease management for the above diseases.
- To study the biology and ecology of major insect pests.
- To screen and identify resistant/tolerant germplasms against pod borer.
- Development and evaluation of safe and economic integrated pest management options against major insect pests.

A. Pigeon pea Breeding:

Crop varieties developed

1. Significant Achievements:

Sl. No.	Variety Name	Release agency	Year of release	Recommended areas	Description	Yield (q/ha)	Pedigree
1.	UPAS 120	CVRCSVRC	19791984	Rajasthan, Haryana, U.P. and plains of Uttarakhand	Medium tall, spreading, suitable in rotation with the normal sown wheat, escapes frost, extra-early (125-130 days)	15-16	Selection from germplasm P 4785

2.	Pant A 291	SVRC	2008	Plains of Uttarakhand	It matures in 140-150 days and is suitable for Arhar-Wheat rotation, seeds are dark brown of medium size, resistant to phytopthora blight, wilt and sterility mosaic diseases of pigeonpea	20-25	UPAS 120 x KPBR 80-2-1

Crop varieties released (yet to be notified)

Sl. No.	Variety Name	Release agency	Year of release	Recommended areas	Description	Yield (q/ha)	Pedigree
1.	Pant A 4	SVRC	2018	Plains of Uttarakhand	Indeterminate growth habit, Dark Brown seed coat colour, Medium bold seed, Resistant to phytopthora stem blight and moderately resist to wilt disease	15-20	UPAS 120 x ICPL 88039
2.	Pant A 5	SVRC	2018	Plains of Uttarakhand	Indeterminate growth habit, Reddish Brown seed coat colour, Medium bold seed, Resistant to phytopthora stem blight and moderately resist to wilt disease	15-20	ICPL 84023 X Pusa 992

Donors identified at the centre

Besides the development of the elite lines/high yielding varieties, some donor parents for different traits were also identified and are being used in hybridization programme to combine different desirable traits like yield, earliness, bold seed size, disease resistance in segregating generations:

Desirable features	Donor
Earliness	Pant A 106, Pant A 134, Pusa 992 and UPAS 120, AL 201, H 82-1, ICPL 88039, Pant A 291, Pant A 3, Pant A 406, Pant A 409, Pant A 414, Pant A 441, Pant A 443, Pant A 444, Paras, ICPL 84023, ICPL 84024, ICPL 93021 and *C. scarabaeoides*
Number of pods/plant	AL 1401, AL 1455, CORG 1, GAUT 210, ICPL 9815, IPA 94-4, P 80-14,

	Pant A 111, Pant A 134, Pant A 235, Pant A 388, Pant A 300, Pant A 337, Pant A 374, Pant A 406, Pant A 414, Pant A 415, PUSA 2001-3, PUSA 2002-1, PUSA 992, TAT 103, TAT 144, UPAS 120 and Pant A 291
Number of seeds/pod	AL 1455, CORG 1, GAUT 99-4, H 82-1, IC 4-1, ICPL 1, ICPL 58010, ICPL 86005, ICPL 88099, ICPL 90025, ICPL 91031, ICPL 93021, ICPL 94001, ICPL 98009, IPA 94-4, Pant A 111, Pant A 288, Pant A 291, Pant A 374, Pant A 392, Pant A 406, Pant A 411, Pant A 415, Pant A 419, PUSA 2001-2, PUSA 2002-1, RTS 1, *Cajanus platycarpus* and *C. scarabaeoides*
100 seed weight	PUSA 992, H 82-1, ICPL 87115, Pant A 291, Pant A 374, Pant A 402, Pant A 414, Pant A 419
Maruca (< 10% damage)	Pant A 104, GAUT 9004, GAUT 88-8, ICPL-288, ICPL 84031, ICPL 85059, ICPL 85030, ICPL 87091, ICPL 87109, ICPL 85030, ICPL 87091, ICPL 87109, ICPL 88026, UPAS-120, Pant A 291, Pant A 406, Pant P 441, Pant A 444, *C. scarabaeoides* and *C. acutifolius*
Phytophthora Stem Blight	KPBR 80-2-1, *Cajanus platycarpus*
High yield	UPAS 120, Pusa 992, AL 1381, AL 201, AL 1455, H 82-1, ICPL 88039, GAUT 210, Pant A 291, and Pant A 3, Pant A 300, Pant A 337, Pant A 374, Pant P 406, Pant P 409, Pant A 414, PANT A 419, Pant A 441, Pant P 443, Pant A 444, Paras and ICPL 84023

B. Agronomy

1. Significant Achievements:

- Planting on raised beds and ridges increased the pigeonpea yield by 44 and 37 % over traditional flat bed method. Flat bed followed by furrow method significantly yielded more than flat bed.
- Ridge and raised bed plantings caused lower incidence of *Phytopathora* stem blight in initial stages and also reduced the weed dry weight.
- Intercropping of Pant U 31 with pigeon pea (UPAS 120) recorded significantly higher grain yield (533kg/ha) than remaining urdbean genotypes.
- Among the two intercropping systems, pigeon pea + urdbean was more remunerative than pigeon pea +maize.
- Application of RDF (20:17:20:20 of NPKS) + FYM @ 5t/ha being at par with RDF + vermicompost @ 2.5t/ha recorded significantly higher yields of pigeonpea, component crops (Maize, urdbean) and PEY over recommended dose of fertilizer alone.
- Seed inoculation with PSB also gave higher PEY over control.
- Among herbicides pre-emergence application of pendimethalin 0.75 kg /ha followed by post-emergence application of imazethapyr 100g ha, 15 DAS, + one hand weeding 50 DAS being on par with pre-emergence application of pendimethalin 0.75 kg /ha, 3 DAS followed by post-emergence application of quizalofop ethyl 100 g ha, 15 DAS + one hand weeding 50 DAS, post-emergence application of imazethapyr 100g ha, 15 DAS + one hand weeding 50 DAS, recorded significantly higher pigeonpea grain yield over remaining treatments.
- Integration of INM, IWM and IPM, being on par with INM + IWM (pendimethalin 1.0 kg /ha, PE + imazethapyr 100g ha, POE, 15 DAS, + one hand weeding, 50 DAS) recorded 38, 40 and 52 per cent increase in grain yield of pigeonpea over INM, IWM and IPM alone respectively.

C. Plant pathology

1. Significant Achievements:

-Phytophthora stem blight (PSB)

Screening of germplasm lines/cultivars:

Germplasm lines/cultivars received/included (288 Nos.) in various coordinated trials were screened. Several germplasm lines were found resistant viz; ERG65, GT 101, BSMR 736, BSMR 579, ICP 2376, RVSA-07-22, WRG 232, WRG196, MA-6, IPAC-3, AKTE 10-12, BRG 2, BRG 3, BRG 5, BRG 14-2, BSMR 2, BSMR 243, BSMR 571, GRG 160, IPA 204, JSA 28, KPL 43, KA12-2, MA 6, PT 257, PUSA 2014, PUSA 2014-2, PUSA 2014-3, RVSA 07-10, RVSA 07-22, RVSA 07-29, RVSA 07-31, RVSA 2014-1, RVSA 2014-2, TJT 501, WRG 242, WRG 244, WRG 246, WRG 248, WRG 252, WRG 256, WRG 280, WRG 292, WRG 293, WRG 297, BAHAR, DA-15-2, DA 15-1, KPL 43, WRG 248, PT 00012(C), BSMR 736, KDVP 1935, JKM-189 (C), KA 13-5 and WRGE 140.

M--odule for management of PSB

- Use of resistant cultivar (AL1593, PA291, PUSA 2014, BRG 5).
- Seed treatment with metalaxyl @ 5 g/kg seed
- Sowing in the first fortnight of June on ridges.
- Sprays and drenching of ridomil @ 0.25% as soon as disease is appeared.

Cercospora leaf spot

Symptomatology: A detailed study of the symptomatology of the Cercospora leaf spot of pigeonpea was carried out. During early stage, symptoms were seen as brown spots, later turning to dark brown, with grey to dirty grey centers were observed due to sporulation. Later on lesions coalesce and causing blightening and premature defoliation. Symptoms also appeared on pods and stem under severe infection.

Morphological Studies: The mycelium was filamentous, branched septate, hyaline to subhyaline to yellowish brown, measuring 1.5-4.0µm. Conidiophore came out from stomata in dense fascicles. Conidiophore were amphigenous, unbranched straight, septate, geniculate, measuring 24-145 x 3.5-6.5 µm. Conidia were obclavate, cylindric, hyaline, septate, with truncate base and acute tip, measuring 3.5-215.0 x 2.5-5.0 µm in size.

Effect of media: Ten culture media were used to study their efficacy in enhancing the growth and sporulation of *Cercospora cajani.* Growth characters revealed that *Cercospora* produced circular whitish to oilvaceous colonies on all media tested. The maximum colony diameter was observed on carrot leaf decoction agar medium (CLDA) and pigeonpea leaf extract oat meal agar (PLOA), medium, while on V-8 juice and Czapek's Dox it was moderate and relatively less colony diameter was observed on PDA, Richard's medium, oat meal agar, malt extract agar, yeast extract agar and Asthana and Hawker's medium. Out of above media maximum colony diameter 35.33, 39.31 and 51.88 mm was observed in carrot leaf decoction agar medium on 7, 9 and 15 days of incubation period, respectively while V-8 juice, Czapek's Dox, CLDA and MLOA supported sporulation.

Effect of Temperature: Maximum growth was observed at 30°C followed by 25°C and no growth occurred at 5, 10 and 40°C temperature, while maximum sporulation occurred at 25°C and no sporulation at 5, 10, 35 and 40°C temperatures.

Effect of Bioagent: *Trichoderma harzianum* and *Pseudomonas fluorescens* were screened for their antagonistic potential against *Cercospora cajani. T. harzianum* over grew and parasitized C. *cajani* completely after 8 days of inoculation.

Effect of Fungicides: Ten fungicides were evaluated *in vitro* by poisoned food technique. Roko thiophanate methyl. was found best among all the tested fungicides at 2.5 ppm concentration, resulting 58.4 per cent inhibition over check.

Effect of Botanicals: Among the plant extracts evaluated *in vitro* by poisoned food technique neem leaf extract was found most effective resulting in 52.6 per cent inhibition at 1 per cent concentration.

In field condition prophylactic spray of fungicides, bioagents and plant extracts significantly reduced disease severity and enhanced yield as well as thousand grain weight.

Module for management:

- Seed treatment with *T. harzianum* 8gm/kg seed two days before sowing
- Spraying of thiophanate methyl 0.2per cen at disease appearance.

D. Entomology:

1. Significant Achievements:

Biology and Ecology

- Among the 70 species of insects including pollinators and natural enemies recorded the legume pod borer, gram pod borer, pod flies and bugs on early maturity were the major constraint in production of pigeonpea. The incidence of *Maruca* was followed by *H. armigera*, *C. gibbosa* and *M. obtusa* started from flowering stage, 44th (pod formation stage) and 46th standard week (pod maturity stage) to till 49th, 50st and 51st standard week, respectively (pod maturity stage).
- ***M. vitrata*** Webs of *Maruca* started to appear from bud stage of the crop i.e. from the 39th standard week and remain continue upto the 48th standard week. The maximum webs 14.5 webs/plant were observed in 43rd standard week whereas, minimum incidence of 0.8 larvae/25 shoots was observed during 48th SW. The webbing of shoots by *M. vitrata* was found to have significant correlation with maximum temperature. *M. vitrata* and *Grapholita critica* larvae showed significant positive correlation with maximum temperature, minimum temperature and evening relative humidity. *M. vitrata* dominated from first week of September to second week of October with its 100 per cent share to pest complex of pigeon pea. From correlation study in pigeon pea revealed that *M. vitrata* activity enhances with increasing maximum and minimum temperature and vice versa.
- ***Helicoverpa armigera*** The peak period of *H.armigera* occur during October – November on early pigeon pea. In recent years, the damaging population was found to be low on early pigeon pea. The population of *Helicoverpa armigera* was observed from 39 standard week (September 2015) to 46th SW. The population of *H. armigera* was ranged from 0.0 moth /trap to 3.20 moth/ trap per week. The incidence of the insect was coincided with the bud formation stage of the crop. The moths of *H. armigera* was recorded from 39th to 46th standard week.
- ***Melanagromyza obtusa*** Pod fly, *M. obtusa* is active from October to April, hence all group of pigeonpea. i.e. early, medium and late maturity are attacked. During the period *M. obtusa* was first observed in 45th SW and persisted upto 52nd SW at pod maturity stage of the crop. Maximum mean maggot and pupae population (19.2/25 pods) were observed during 46th at pod maturity stage. Its population had negative correlation with maximum and minimum temperature and minimum relative humidity.
- ***Clavigralla gibbosa*** The inicidence of *C. gibbosa* was first observed during 43th SW at pod formation stage and the mean nymph and adult population was recorded maximum 12.8/ plant during 46th SW. The nymph and adult activity of *C. gibbosa* observed to enhance with increasing maximum relative humidity and wind velocity as showed positive correlation, however decreased with increasing maximum and minimum temperature.

Host plant resistance

M. vitrata, podfly and pod bugs were the major constraints in the cultivation of pigeon pea. Pod damage during 2010-2015, ranged 3.34 to 72.50 per cent through lepidopterans and from 3.82 to 35.46 per cent by pod fly were recorded on early maturing lines and 2.13 to 6.0 per cent on late maturity types.

Integrated Pest Management

Biological control

- Eleven natural enemies *viz., Coccinella*

septumpunctata, Menochiles sexmaculata, Harmonia sp., Eocanthecona furcellata, Rhynocoris fuscipes, Mantis sp., Euderus agromyzae, Chrysoperla carnea, *Apanteles glomeratus, Diaretiella rapae, Bracon sp, Gambroides javensis , Opius sp, Xanthopimpla flavolineata, A. obliqua* and spiders were found to be associated with the insect pest complex, regulating the insect population under natural condition. However, among these natural enemies the *E. furcellata* was identified as a potential predators of lepidoperan insect pests viz., *M. testulalis*, *G. critica*, and *Spodoptera litura*. The adults and nymphs of predatory stink bug, *E. furcellata* was found feeding on the larvae of spotted pod borer, *Maruca vitrata* during 38th to 46th standard week. The maximum population of bug was observed during 40th standard week. This was the first report of predation of *E. furcellata* on *M. testulalis*. Further augmentation of the *E. furcellata* required proper attention.

Chemical control

- Several insecticides evaluated which gave very good control of pod borer complex and greater grain yield in pigeonpea crop. Alternate spray of chlorantraniliprole 18.5 SC @ 30gai/ha and spinosad 45 SC @56gai/ha was found to be most effective with minimum total percent pod damage of 11.79% and maximum grain yield of 1161.70 kg/ha. However, Alternate spray of indoxacarb 15.8 EC @ 73gai/ha and *B.t.* serovar kurstaki @ 1.5 kg ai/ha was most economical with maximum cost benefit ratio 1:4.83. However, in sequential application of Chlorantraniliprole18.5 SC (at bud stage) followed by indoxacarb 15.8 EC and acetamiprid 20 SP) gave minimum percent pod damage by *Maruca and* podfly with maximum grain yield (1357.77kg/ha).

Use of biopesticides

- Pod damage due to borers varied significantly from lowest of 22.17 per cent in commercial *B. bassiana* @1.5kg/ha followed by 23.81 NSKE 5% to the highest of 48.04 per cent in untreated control. Grain yield varied from maximum of 824.99 kg/ha in commercial *B. bassiana* @1.5kg/ha followed by 801.10 kg/ha in NSKE 5%.

Integrated pest management modules

- Chlorantraniliprole 18.5SC @30 g a. i./ha at bud initiation stage gave good result for the management of *Maruca*. Acetamiprid 20SP @ 20g ai/ha gave highest protection against podfly. Alternate spray of Indoxacarb, Neem soap and acetamiprid gave highest benefit: cost ratio of 2:1 in Manak variety.